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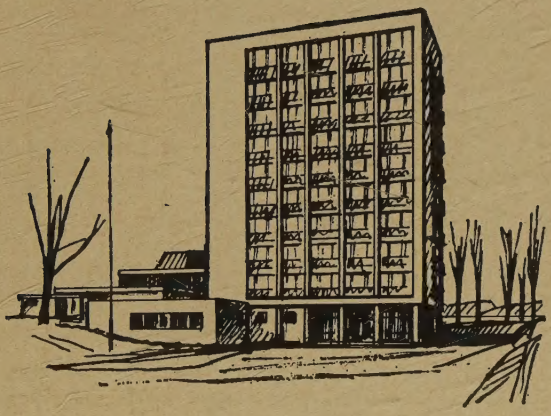

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NORWEGIAN FISHERIES RESEARCH

BY

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INTRODUCTION

It is man's eternal desire to know more about the world he lives in and the life with which he shares that world, that is the source from which research draws its strength, a source as neverending as nature's store of secrets. But research is powered by more than just a desire to see what lies behind the blue mountains, it is driven forward by the instinctive feeling that he who knows more is better equipped than he who knows less. It is these two different motives that underlie the division of research into two branches — the basic and the practical. The thirst for knowledge and the thirst for power are as old as the human race, and for just as long have basic research and practical research gone hand in hand, inseparable, although the goals they strive to reach are so different.

Basic research seeks relentlessly outwards and inwards. It conquers new and unknown country, breaking narrow paths which open the way for thought and understanding, but no-one knows where its paths lead. *Practical research* follows, it seizes the new ideas, and widens the narrow paths to broad roads which make the new country accessible and useful.

It is not always easy to see where the one ends and the other starts, but it is essential to make a clear distinction between the two, because the demands we make of the twin branches of research are so completely different.

We demand that *basic research* shall widen its scope to include all unknown areas. We demand that it shall unceasingly return with new ideas and new knowledge but we demand no accounting. We do not ask for a profit. We demand that *practical research* shall concentrate on specific tasks which we know or believe include values which can be utilized. We demand that it shall fit the new ideas into their place in a larger pattern and we demand that it shall pay!

herring disappeared completely from coastal waters it had visited faithfully for two or three generations, and the cod no longer came to its old spawning grounds.

Coastal communities and towns had grown up with the fisheries, confident that the fish would always be there. Vessels, gear, wharfs and warehouses were kept in repair, and from the towns bales of fish and barrels of herring were sent to old customers abroad. Then, suddenly, everything came to an end.

For some years people still hoped that things might again be as before, but an end had to come to that too. Boats and gear rotted, and old skills were buried with those who had practised them. It was little comfort to read in the sagas that all this had happened before.

CONTEMPORARY ACCOUNTS OF THE FAILURE OF FISHERIES

Peder Claussøn Friis (1545—1614), a clergyman in Undal and the dean of the fief of Lister wrote of his time, his country and his landsmen, but also of the animals of the land, and the creatures of the sea. In a chronicle entitled «Of the Animals, Fish, Birds and Trees of Norway» there is a chapter headed «Of Herring». He writes:

«This lovely silvery fish is a harmless and innocent fish, and is not only given to man for his food, but also to other fish for their prey, for it can no resistance offer, and if it does come up out of the water, it dies. It goes together in great swarms, and at night the water shines where the herring runs, and this fish does not live only of water as some do think, but also consumes small fish and other minute creatures of the sea, as can be seen when the belly of the herring is slit open.

It comes up to the shore here from the great fishpond which is the Icelandic Sea, towards the winter when the great part of other fish have left the land. And the herring does not seek the shore along the whole, but at special points which God in his Good Grace has found fitting, and here in my days there have been two large and wonderful herring fisheries at different places in Norway. The first was between Stavanger and Bergen and much further north, and this fishery did begin to diminish and fall away in the year 1560. And I do not believe there is any man to know how far the herring has travelled. For the Norwegian Books of Law show that the herring fishery in the most northern part of Norway has continued for many hundreds of years, although it may well be that in punishment for the unthankfulness of men it has moved from place to place, or has been taken away for a long period. So it was also with the herring fishery between Stavanger and Bergen that they did draw so many herring on shore that they lay in great piles, and because they could not make out to salt them, or to sell them, they did forswear

their own herring (for it was forbidden to draw more ashore than they could have control of) and did allow them to lie and rot — and then new taxes and duties were also laid upon them. And after that the herring came no longer. The other herring fishery was at Marstrand and along Vik from Marstrand to Homborsund, which fishery did begin in the year 1556, not many years before the more northerly fishery did end. And it is said that in times gone by there had also been such a herring fishery at Marstrand, which did continue, but which was ended long ago.

In the year 1587, on the 27th day of November, a herring was taken at Falder in Viken which was painted on both sides with wondrous letters and figures. Much has been written about this herring and the painting upon her, with its signs and symbols, has been expounded in many ways. But we, the poor people of these two Kingdoms of Norway and Denmark do believe that this herring was a warning from God, and did bode us no good, for in the following year, 1588, on the 4th day of April, our most beloved master and most gracious Sovereign King Frederik was taken from us by death's hand, and was called by the Almighty God to a better Kingdom. This has been a great sorrow and tribulation for his subjects, for we do know most certainly that this is a punishment for our sins. And God did also let the herring fishery fall away in the following year, and has since taken it from us, so that now in this year 1599 no herring has come. If this has befallen:

1: For the great ungodliness of the fishermen with their strife, their blows, their evil language;
2: for their thievishness and unfaithfulness to other, in that they do often steal nets of fish from poor strangers;
3: for the loose and debauched manner of life common among them, with drinking and fighting and other evils incumbent upon these; it did happen that a woman gave birth to a child as she stood in the boat and packed herring, and she threw the child into the barrel, and salted it among the herring;
4: for that the Sabbath and other Holy days are not observed, although it be strictly forbidden to fish in the forenoon of such Holy days;
5: and perhaps for the failings and shortcomings of the magistracy and the officers of the Customs.

If it is for these reasons that God has taken this blessing from us, may God judge, and others after their own judgment.»

Erik Hanssøn Schønnebøl, in «The Description of Lofoten and Vesteraalen», 1591, has given a vivid picture of the struggle for existence of the fishermen in the country of Nordland: «.... and as often as they go out on the sea, they do for the most part catch enough that they may cook for their use, and sometimes more. However, there are three special times in the year when there are three fisheries for which each man prepares, and it is these fisheries which do nourish and support them, and if these three do fail there are many miserable villains over the whole of Nordland, but when these fisheries are good they are a great gift from God into this land.»

About two hundred years later the clergyman and naturalist Hans Strøm (1726—1797) wrote his «General Description of Sundmør». Strøm also discusses the various fish and fisheries, and it is of interest to read what he writes about herring:

«The other important kind of fish, with which foreign trade is carried on, is the herring, and then especially the so-called spring herring, which is taken in nets in the winter or immediately after Christmas. This fishery is not very old, as it cannot be said to have begun earlier than the year 1736, or more rightly 1740, at about the same time as the last period of bad harvests and hardship in Norway. It was first here in Vester-Leden, or the Nordenfjeld coast (in the counties of Nordmøre, Romsdal and Sundmøre) that indescribable numbers of whales and spring herring were seen to come in from the sea and to fill all the fjords and bays. It is true that this kind of herring was not hitherto quite unknown, but to see it in such abundance, and in company with so many whales, was so new and strange that a great part of this first year passed before the fishermen learned to catch it and to make it into Trade Goods, as it is called. Nevertheless it has served for food and sustenance for many both here and elsewhere during these last years of hardship, and it does truly appear that God has opened a great pantry in the sea, as He has closed another on shore, and has so conferred a boon that should never be forgot. After the passage of some few years fishermen began to make full use of this fish, and exceeding great quantities have been salted down and shipped,[1]) but from Sunfiord and other places nearer Bergen, although from no place more than from Christiansund, where between 70 and 80 thousand barrels of herring have been salted down nearly every year, and where great flocks of people have taken up their abode for the sake of this work.

This fish is also very often used for fodder for cattle, which eat of it with great appetite, and has thus in many ways done more for the prosperity of the land than might readily be imagined. But as the herring now begins to fall away, and comes each year later than the year before, it is to be feared that it will with time desert our coasts completely, and will find another way.»

In a foot-note Strøm adds:

«This prophecy has since been fulfilled, as there has no spring herring in this place since the year 1756. It is true that it has been seen in later years in the sea and off the coast, but it has been unwilling to turn into our shores, and has passed us and gone further to the South. After visiting our shores each year for twenty years it has taken leave of us and turned to our neighbours.»

As to the cod fisheries, Strøm tells us that the catches in 1714 and 1715 were so poor that many fishermen «fearing future loss did desert their trade and sell their fishing boats».

Neither should we omit to include what the clergyman and chronicler

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[1]) Not only from this county. . .

Petter Dass (1647—1707) writes about the bad years he experienced:

With empty hands sat the women on shore
Not enough food 'twixt cupboard and store
To fill a hen's crop.
The winter it went and March came around
The men tried every bank and ground
Their fathers had found
So cold and stiff they sat and waited
But none among them worthy was rated
To draw fish from the deep.

Our information about the fisheries of earlier centuries must be sought from disconnected sources, but the quotations given here are sufficient to show the unstable foundation on which one of the main industries of our country rests, and the consequences of the failure of a fishery.

THE STATE BECOMES INTERESTED

The first attempt on the part of the authorities to make a survey of the Norwegian fisheries took place in 1795, when Jens Rathke was sent out to inspect the fisheries in order to make suggestions for improvements. Rathke's report does not deal with the natural foundation of the fisheries, but gives a detailed description of how fishing was carried out along the various stretches of the coastline, harbour conditions, and possibilities for development.

Rathke's sober and open criticism of the state of the Norwegian fisheries should have made a deep impression — for it revealed that in the year 1800 fishing was carried on in Norway in the same way as in the Middle Ages. Foreigners went off with the profit, and it is obvious from his report that Rathke was driven to despair by the restrictions, the disputes about gear, and all the other factors that hindered the development of the fishing industry in Norway.

Nevertheless, at about this period the coast and the sea outside began to be viewed with greater interest. The survey and ordnance work which had been started in the middle of the 18th century was gradually expanded to include the outlying skerries. The authorities wanted the survey also to include the coastal waters and soundings of the harbours, they wanted lists of anchorages, descriptions of hidden reefs, details of the approaches from the sea to the most important harbours and outports. They asked for suggestions for the placing of entrance marks and light-houses to guide ships and fishing boats. In 1841 a number of major surveys and sounding projects were completed. They were excellent for

the day, but were of course neither sufficiently extensive nor sufficiently exact.

It was at this time that the foundation was laid for modern marine research — and it was laid in Norway!

The 19th century was a great period for Norway. It had been for centuries what is to-day called an underdeveloped country, but now outstanding men in many fields brought Norway forward among the nations.

It was not only in literature, music and painting that Norway brought itself to the notice of the world outside — many Norwegian research workers and scientists were also counted among the foremost of the time.

It was the epoch-making research and scientific philosophy of two of their number — father and son — that gave the study of marine life new content and new goals. These two were Michael Sars and Georg Ossian Sars.

THE SCIENTISTS GO TO WORK

Michael Sars (1805—1869) was born in Bergen, where he attended school. His interest in nature was strengthened by interested teachers and both as a school-boy and later as a student of theology he carried out independent studies in biology.

Michael Sars' first living was at Florø, later he took over the parish of Manger. During the twenty-four years he lived by the sea he made studies of marine life, as well as carrying out the work of his parish. Using the simplest of equipment he found and studied a number of previously unknown marine animals and his descriptions of them and their development aroused such interest in the world outside that he soon came to be considered as one of the leading zoologists of the time. In 1854 a Chair of Zoology was created for him at the University of Christiania (now Oslo).

It was Michael Sars' conception of the importance of zoology that distinguished him from his contemporaries in other countries. For him zoology was not a dry description of rare animals — it was a means of explaining the multitudinous phenomena of life, the wonderful interaction of the organs, and the reciprocal relationship between the individual and the rest of nature. This conception of life and its forms was new. The ideas which guided Charles Darwin were very similar, and Michael Sars can undoubtedly take place beside Darwin as one of the founders of modern zoology.

Georg Ossian Sars was born in Florø in 1837. In his father he had the best of all taskmasters, and he had no hesitation in choosing to study

zoology. When the father went to call on his parishioners on the islands along the coast his son went with him, and together they discovered a new and unknown world. It was not long before G. O. Sars began to publish the results of his own studies, and it immediately became clear to all zoologists that there was a new and significant naturalist in Norway.

The influence of Michael Sars was not confined to his own son, he awakened in many young students an interest in animal life in the sea and on land. He may also be said to have been responsible for winning the understanding of the authorities.

In 1853 Michael Sars' contemporary, P. Chr. Asbjørnsen, who not only wrote and collected fairy tales but was also a zoologist, brought up a huge and luminous starfish from the Hardanger Fjord, from a depth of 400 metres. Asbjørnsen called it *Brisinga* after the jewel which the dwarfs wrought for Freyja, but which was stolen by Loke and hidden at the bottom of the sea.

Asbjørnsens' starfish aroused attention among zoologists the world over, because it represented a transition form between other types of starfish. But the real world-wide sensation came when Michael Sars published a description of a long-stalked « sea lily» which his son, G. O. Sars had found at a great depth in the Lofoten islands. Scientists had believed that stalked «sea lilies» had been extinct since a very remote period, as they were known only from fossils dating from the pre-historic age. It was said: «The discovery of this «sea lily» in the present day is just as remarkable an event for the naturalist as it would be if someone discovered a live plesiosaurus, or if a mammoth was found wandering in some deep forest.»

It was for two reasons that these discoveries awakened such interest wherever they became known. The first was the current belief that no life existed in the great depths, the second was that the sea now appeared to hide forms of life which were capable of explaining some-of the mysteries of life and of science.

The significance of these two, Michael Sars and his son, in the development of fishery and marine research is generally recognized. It was to a great degree due to the stimulus of *their* work that major marine research expeditions were sent out by Norway and by other countries in the 1860's and 1870's.

As formerly mentioned, in the middle of the 19th century the belief that a study of marine life might explain the fluctuations of the fisheries began to gain ground. 1859 was a memorable year, Parliament made its first grant for this purpose, charging Axel Boeck with the task of studying the herring and the herring fisheries. In 1864 Georg Ossian Sars was made a grant for the purpose of studying the cod and the

Lofoten fisheries. So these two young scientists settled down to their gigantic problem — finding the causes of the fluctuations in the Norwegian fisheries.

1864 was memorable for another reason also — it saw the publication of Løberg's large and significant work: «The Norwegian Fisheries.»

Ole Nicolai Løberg (1804—1868) was the Dean of Ryfylke and the Member of Parliament for Stavanger for a number of periods. He was forced by tragic circumstances to give up both his office and politics, but he found other values to occupy him. He took up the study of the history of Norwegian fisheries and the fishermen's economic condition, and he left behind him one of the most valuable contributions ever made towards the critical analysis of one of our natural industries. In the course of 323 closely printed pages Løberg gives a detailed description of our fisheries, gear and species of fish. He describes the manner in which the fish is cured and shipped, and gives details of markets, prices and official measures.

Reading Løberg's compact little book to-day, one is left with two impressions. The first is admiration for his punctiliousness, his honest intention to give a true description of the condition of the fisheries, and his constructive criticism of the factors which prevented Norway from developing into a greater fishery nation. The second impression which remains is the feeling that this book must have been written to-day, and not a hundred years ago!

Løberg's account of the fluctuations in the herring fisheries is of especial interest for fishery research. He has compiled information from the sagas and from more recent sources concerning the time and location of herring fisheries in waters off the coast of Norway and the south of Sweden. He lists definite periods when there have been herring fisheries, and others when the herring has kept away. In the case of the 17 th and 18th centuries he is able to give the years or year in which a herring fishery ended og started.

In about 1576 the herring disappeared from West Norway, after having visited the coast in great quantities for many years.

In the first part of the 17th century there was again a spring herring fishery in West Norway, but it appears fairly certain that no herring was fished between 1650 and 1654, a new fishery having apparently started in 1699 or 1700. After giving this piece of information Løberg adds: «This is the longest period in recent times during which no accounts of herring fishing can be found, and this period may perhaps be the sixty years for which, according to tradition, herring have stayed away from the coast of Norway.»

From the beginning of the 18th century there are accounts of the next herring fishery. The years between 1740 and 1760 were particularly rich — but after 1784 there were no more herring.

In 1808 a new spring herring fishery began, and was in full progress when Løberg wrote his book. (We know that this fishery ended in 1873 and that it was almost forty years before spring herring again appeared in quantities on its old grounds.)

It was truly a sea of mystery that Axel Boeck and Georg Ossian Sars now were to engage. Where did the herring come from when it came, and where did it go when it left? And the millions of cod that gathered on the spawing grounds of the Lofotens Whence?

Why? How?

The two young researchers began cautiously, with a humble and modest approach to the task they had been given. They looked for some loose ends in the tangle of questions which had been posed. Boeck had a lead of a few years, and had made a good start with his work on the herring when Sars began his study of the cod.

AXEL BOECK AND THE HERRING

Axel Boecks' report on the herring research he had carried out was in 1871 sent to the Royal Norwegian Ministry of Interior Affairs and was published later in the same year in book form: «The Herring and Herring Fisheries, in particular the Norwegian Spring Herring Fishery.»

Boeck did excellent work during his six years of research. His conscientious studies on the spawning of the herring, the herring egg and its development, the formation of herring schools, their approach to the coast, and their rate of growth are of great use even to-day. Of especial value to his contemporaries was the work he did in sweeping away old prejudices and superstitions concerning the fluctuations of the herring fisheries. In a special section entitled: «Concerning Herring Periods and the Cessation of Herring Fisheries» Boeck followed Løbergs' example in giving a number of extracts from old and new works relevent to the fluctuations in herring fisheries, but Boeck made an effort to discover some system in the apparently random movements of the herring. He found that there were certain trends in the behaviour of the herring in the successive fishery periods. At the beginning and end of a period the herring approached the coast much later than in the middle of the period.

The herring period Axel Boeck experienced in person began in 1808. He recounts that in 1860 fishing started in January, but that in

the following years the herring made its appearance later and later, so that in 1869—70 the fishery was not in full progress until far into February.

Boeck also demonstrates the gradual displacement of the fishery along the coast within a fishery period, both in West Norway and in Bohuslän (in the south of Sweden).

His report, which covered the situation up to 1870, contains these words: «The circumstances being as described, the question arises whether there are now other indications, in addition to those listed, that our spring herring fishery may sooner or later come to an end, at least in the more southerly fishing grounds.»

As formerly mentioned, the West Norway herring fishery ended in 1873.

GEORG OSSIAN SARS AND THE COD

Both Sars and Boeck took part in the fisheries themselves, and acquired their information at first hand, and by their own observations. So when G. O. Sars was allowed a government grant in 1864 in order to carry on fisheries research he went to the Lofotens to meet the cod and its secrets on its own ground. In the introduction to the report written after his first visit to the Lofotens he says: «Wherever I went I paid careful attention to the movements of fish and to those physical conditions which might be thought to have any influence on this movement, and I also listened attentively to experienced fishermen's accounts of the fisheries, considering this of especial importance to me, who am not yet well acquainted with conditions up here.»

In the first year Sars made a discovery which aroused great attention among researchers the world over. In his own words:

«The earliest spawning I observed during the last Lofoten fishery took place at the end of February at the head of Østnæs Fjord. By fishing with a fine plankton net I brought up some small and perfectly transparent globular bodies, which floated freely in the water and which I first thought to be some type of lower marine creature, as I was then quite ignorant of the remarkable manner in which the cod spawns, which I shall in the following describe further. I had already heard some fishermen claim that the spawn of the cod could be found floating in the sea, sometimes in such quantities that the water appeared opaque, but as this was in conflict with what was already known about the spawning of fish, I could only assume that what the fishermen spoke of was some kind of primitive marine animal, as these animals often appear in myriads in the sea. I did not expect to find the eggs of the cod anywhere but at the bottom, from which I could take them with my bottom dredge. However, a microscopic examination of these small globular

bodies showed with certainty that they were eggs, although the embryos were not so well developed that it could be determined whether or not they were the eggs of fish. Later these floating eggs appeared in greater quantities, until by the end of March they filled the sea everywhere, so that I was able to obtain as much of them as I wished. It was now a simple matter for me to trace the development of the embryo step by step, until the minute larva made itself free of the surrounding eggsheath and swam freely in the water.

This strange feature of the eggs of the cod, to which no parallel has hitherto been observed, may have is cause partly in the lack of any of the conglutinative substance which has been seen in other fish to surround the grains of the roe, and partly in the presence of a presumably unusual amount of oil well distributed through the yolk, this making the specific weight of the egg very slightly less than that of water. It is only when the embryo is dead, and the yolk has consequently shrivelled up, that the egg will sink to the bottom, otherwise it continues to float freely in the water during the whole subsequent development. Even the newly hatched larva continues to float in a similar manner, attached to the voluminous pendant yolk sac which forms its only sustenance for some time to come.»

But the cod did not reveal all its secrets quite so easily. Where did they come from, the millions upon millions that swarmed towards the Lofoten banks in the first months of the year? And where did they go after spawning near the Lofotens? Sars concentrated his interest on these two questions. He had an end of the tangle to pull on, he had found the eggs of the cod, he had seen its larvæ hatch. The next problem was to follow the futher development of the larvae, and find out what became of them.

But now it seemed as if the cod laid traps for Sars. It did not arrive with clouds of gulls and blowing whales as did the herring in its approach to the coast. The path of the cod towards the banks of Lofoten was invisible and untraceable. Suddenly, with no warning, the cod were there, packed so closely that the sinker of the jig bounced from cod to cod.

Some thought that the cod came from a remote distance, some that it remained just off the coast between spawnings. At the end of his first Lofoten season Sars inclined towards the second of these opinions. He was wrong, but later corrected his mistake.

Two sentences in his first report show that Sars was on the track of the great central problem of the fluctuation in fisheries. After having described how vulnerable the eggs are, and how they drift hither and yon in open water with the wind and the current, he concludes that spawning which takes place in more closed fjords will be more advantageous for the propagation of the cod, and therefore for future Lofoten fisheries. Then he says: «The question is whether it might not be possible to help

Nature by artificial means as an insurance against bad fishing years in the future, bad years which would make themselves felt so severely not only on those immediately interested, but on the welfare of the whole country. I refer here to artificial hatching of fish.»

Let us look a little more closely at this short paragraph. Sars poses the question of whether it is possible by «artificial means» in other words by human agency, to assist nature and thereby guard against bad fishing years in the future. It is clear that Sars is of the opinion that a fishery failure may be due to eggs or larvae having been exposed to conditions which destroyed them, or prevented them from developing. He foresees the possibility that artificially fertilized cod eggs might be placed in waters where they were protected against waves and current. It was this idea of his that led to the establishment of hatcheries both here in Norway and in other countries.

It has to-day been proved that artificially hatched larvae are capable of surviving, but doubt prevails as to whether artificial hatching of more common fish species could be made a paying proposition.

Sars continued working on the larvae of the Lofoten cod in order to follow its development. He had seen it as a newly hatched larvae about four or five millimetres long, but did not know what it looked like when it was a little bigger. On a fine calm day of May sunshine he found it again, in a protected bay on the east side of Skrova. It was now seven or eight millimetres long. Its body was as thin as a thread, it was the head, with its big eyes, that was easy to catch sight of. By the next time he caught sight of it, it had grown to 24 mm. The three dorsal fins were now present, and even the pride of the cod, its barbel, or beard, had begun to appear in the form of a small protuberance on the point of its lower jaw.

So the search continued. The sea was clear and smooth, there was no plankton to be seen, and Sars found no cod fry, except the odd one or two swimming alone along the surface, separated from their comrades. Sars began to think that the fry had left the coast for good, and that the great swarms he had seen indicated that they collected in the same way as migratory birds collect before they start their travels. He had himself rowed along the shore — in the bays and out in the Vest Fjord — drawing his plankton net after him, but he still found no fry. Then he moved from Skrova to Brettesnes, and here, in his own words, is what he found:

«The first day did not go better than at Skraaven, and I had almost lost hope of finding them (the fry) again, when I one fine calm day, the 5th of July, as my men were rowing me about in a deep bay which penetrates far inland, happened to catch sight of a little fish, almost

completely hidden under a large jellyfish (Cyanea capillata), so that only the end of its tail protruded from beneath the disk of the jellyfish. I brought up both jellyfish and young fish by means of a net of fine gauze, and found to my delight that it was really a young cod. It will be readily understood that I now began to pay the greatest attention to these so common marine animals, which I had hitherto hardly offered a glance. The same phenomenon repeated itself. Under most of the jellyfish one or more small fish were hidden. They were not all cod. among them was another sort of fry, immediately distinguishable by virtue of its shorter and plumper shape, which I on closer examination found to be the fry of our common Haddock (Gadus aeglefinus). I found only these two types of fry in these strange circumstances. I never found the fry of saithe in this way, although there were swarms of this fish everywhere along the shore at this time.

What can be the reason behind this strange relationship between two such widely different creatures? This was, as it may be imagined, the first question I posed myself. The fact that these fry, delicate and fragile as they are at this stage of their development, should search out these gelatinous creatures, whose innumerable poisonous tentacles, stretching in all directions, make them not only an object of terror for smaller animals, but make them quite rightly hated by man, this fact was so beyond my comprehension that I at first thought that the fry had in some way got into the power of the jellyfish against their own will. It might even be possible that this creature exerted some magic power over the poor fish fry, a power similar to that we know tropical snakes to exert on small birds in order to bring them right into their open jaws. However, after careful observation I soon deserted this theory. The fry swam calmly around in all directions between the numerous tentacles of the jellyfish, and at the slightest noise were frightened far from it, only to return after some time. There had to be something which enticed the fry into the neighbourhood of these creatures of their own free will. Perhaps they sought some kind of protection against other fish or marine animals beneath their disks. This explanation was not unfeasible, but I did not find it completely satisfactory. However, by means of the most sedulous observations I have come to the conclusion that the fry collect around the jellyfish chiefly for the purpose of snapping up the minute creatures which serve the jellyfish for nourishment, these creatures being first paralysed by the poisonous tentacles and then gradually drawn up by these underneath the disk. Although the fry thus deprive the jellyfish of some of its rightful prey, they carry out in return an important service which fully compensates for the wrong they thus do it. The fact is that this marine creature is greatly troubled by a parasite, a small crustacean (Hyperia), belonging to the order of the amphipods, which often attaches itself in great quantities to the body of the jellyfish by means of its sharp claws, even eating itself far into the gelatinous mass of which this body is made up. I always found one or more of these parasites which are so troublesome for the jellyfish in the stomack of larger fry. This strange relationship between jellyfish and the fry of fish is, however, not completely without risk for the latter, although it would appear even more often to save them from the pursuit of larger

fish. If these minute and delicate creatures get too close under the disk of the jellyfish they might easily become entwined in its poisonous tentacles, and that would be the end of them. I once found a fairly large specimen of cod fry that had in this way had to pay with his life for his forwardness.»

Sars found the fry not only under Cyanea but also under the harmless Aurelia (moon jellies) and under drifting masses of seaweed. «This was as fas as I got this year,» he says. He did not feel convinced that the bulk of the fry of the cod lived in this manner, but he had other duties, and had to postpone further investigations until the following year — 1867, when he left Christiania in the middle of July, arriving in the Lofotens at the same time as he had left them the year before. «It will be understood that I made all haste to get to the sea as fast as possible so that I could tie up the threads of my observations in both these years. I was fortunate enough to be able to do this on the very first day. Going out from the fishing village of Skraaven I went far out into the Vest Fjord, and observed a few cod fry in the same position, straight underneath some jellyfish swimming on the surface.»

It is a pity that we are unable here to allow Sars to tell the whole story himself, as he has done in his report. On every single page we meet the scientist — and the artist. The words and sentences sound like the tones of a musical instrument, of the violin he always took with him on his expeditions. He sat in his boat and saw the saithe swimming in feed which was made up of his dear cod fry. Each time the saithe chased the fry up to the surface, hundreds of screaming gulls hung overhead, waiting for the feast to start. Sars saw «the poor young fish», but he could not get hold of any of them, so the next day he took a trailing line with him to get hold of the saithe. When he opened the stomachs of the saithe he found large quantities of cod fry, in more or less digested condition, but on one occasion he took out a live specimen and put it in a glass of seawater. It soon recovered, and «swam gayly about, so that I on returning home was able to examine it thoroughly and draw it ..... It was now that I for the first time got a true impression of the remarkably beautiful colour markings of this stage of development. This marking is very unlike that of the full-grown Lofoten cod, making these young fish among the most beautiful we know. The darker transverse stripe which had already begun to appear on the largest of the cod fry I had caught in the previous year, had now broken up into 3 or 4 lateral rows of square markings of a more or less vivid reddish-brown hue, forming a pleasing contrast with the light background of the body, and placed so regularly that they almost resembled the squares of a chessboard. As the fish moved the sides of the body and head shone with a particularly

brilliant sheen, alternating between silver and gold. The characteristic barbel was now fully developed, also all the fins, in the same remarkable position with regard to one another as in the grown fish, in short, apart from the colour, it was now easy to recognise at a glance the developing cod.»

The largest cod fry Sars had obtained were between 4 and 5 cm long; it was now late August, and everything he had caught had been caught far from shore. When he examined bays and inlets he had found only the fry of saithe. However, at the end of August he saw that the cod fry had come in to shallow water. They were now so large that he could catch them with small hooks, and everywhere he went he found young cod in large quantities along the beaches and under wharfs. He continued catching fry during the whole of September and the first few days of October, but found to his surprise that the fry had apparently stopped growing. It remained at a length of from 6 to 7 cm. He thought the explanation might be that the larger fry sought deeper water, their place being taken by smaller, «delayed», fry from later spawnings. He tried another type of fishing gear — a catch net made of fine-meshed net stretched over a ring of steel wire. When he placed this net on the bottom with a little bait and waited a while before drawing it up he caught the larger codlings that he was looking for. They had reached a length of 12 to 13 cm, and Sars reckoned out that «more than 3 or at the most 4 years could hardly be required before they would return to their birth-place as fully-grown mature cod, ready in their turn to bring millions of new creatures into the world.»

These months, with the sea lying calm in the midnight sun, with the jagged wall of the Lofoten mountains lit up by an unearthly play of colour, must have been a wonderful time in Sars' life, a time filled with a wonderful task. He perhaps had the feeling that no-one had the right to have quite such a marvellous time on Government money, but he saw the practical significance that the knowledge of the life history of the cod might well have.

It is possible that Sars either felt or heard that he was being criticised for not having more results to show after two years of research. In no uncertain terms he described the plan he had evolved. He would proceed step by step, and would not allow himself to be tempted into making hypotheses or guesses until he had a more certain foundation to build on. He had set himself the goal of throwing light on the natural history of the cod, and considered this an important task. He found it necessary to observe the cod found at other places along the coast, and later in the winter. This would take time.

In the third year Sars arrived at the Lofotens in the middle of

November (1868) after a long and arduous journey. His first plan was to get hold of the young cod that would soon be a year old.

He did not know where to search, or what gear to use. The equipment at his disposal was hardly impressive — a four-oar boat, a catch net, a long line fitted with small hooks, and a double-bite fishline. At least he found young cod of the size he was looking for, and he writes: «Now that I have again got hold of young cod in a new phase of development and have again tied together the thread whose end I for a moment thought I had lost, my next task is to establish even more firmly the results which have been reached, and to gain a general picture of the occurrence of small cod at various points. ... I have thus followed the young cod step by step through the various stages of its development from year's end to year's end, and have thus concluded one of the first and perhaps most important, but at any rate the least well known, chapter in the natural history of the winter cod. I am obliged to postpone the study of the further development of the Lofoten cod until another year, as I have already been up here far longer than I had first intended.»

Sars had considerable difficulty with the problem of the age of his cod. At that time there were no methods for determining how old a cod might be. Sars guessed and guessed, but without success. Another of his problems concerned the so-called coast cod. Fishermen distinguished between this and the true Lofoten cod. They said that the Lofoten cod had a sharper head and longer teeth, and that the thin membrane which lines the abdominal cavity was black in the Lofoten cod, and light in the coast cod.

Sars investigated these assertions, and found that the specimens the fishermen called Lofoten cod really had a thinner body and a sharper head, but he could draw no sharp line between the two types. The fishermen were often in doubt themselves, Sars' conclusion was that it must be all the same type of cod.

Sars concludes his reports for 1868 and 69 with a summary of his results. He has discovered that the eggs of the cod float up, and that they are fragile, he has seen the larvae emerge from the egg attached to the yolk-sacs which will nourish them for the first week of their life. He has seen the young fish eat the minute particles that float like dust in the sea in the early spring. He has found that when they are a little larger they like to hide under jellyfish and other floating objects, and that they later go down to deeper water, having by then taken on the appearance of their parents. He is aware that the fry of cod and the fry of saithe behave completely differently, the young saithe, in contrast to the young cod, passing its first year as a typical shore fish.

He still does not know whether or not there are several different varieties of cod. There are cod all along the coast that do not resemble the Lofoten cod — small cod and shoal cod that never become as large as the Lofoten cod. Sars thought it possible that the fjord cod had poorer living conditions than the Lofoten cod, which has the whole ocean at its disposal. He posed the question of how all the large and small cod of the Norwegian coast find room enough — and where they find it. Again he came to a major problem — we quote his own words:

«As I have mentioned above, it is not yet known with certainty where the Lofoten cod has its true domicile. However, I shall here express my opinion on this point so much more because I for several reasons have found myself obliged to reject the hypothesis put forward in my first report, that the Lofoten cod spent its time in the great deeps between the coastal banks and the shore. On the basis of the observations I have made in recent years I consider it for many reasons to be probable that the whereabouts of the Lofoten cod are found not in the deeps inside the banks, but on the banks themselves. Former studies have established that these banks, which although broken in several places form a barrier of shallows along most of our coast at a considerable distance from shore, are particularly rich in the various varieties of larger fish, large cod being present in considerable numbers. It has hitherto been believed that this cod, which has been distinguished from other cod by the name of «bank-fish», always remained here, and therefore propagated and developed on the banks. However, many of the observations I have made concerning the propagation and development of the cod are incompatible with this. According to my observations all cod without exception must necessarily spawn near the coast, both in order to fulfil the conditions necessary for the fertilisation and development of the roe, and in order that the fry may find the nourishment necessary at the different phases of their growth. To me nothing seems more natural than the assumption that bank-fish and Lofoten cod are one and the same, and that it is just on these ocean banks, far out at sea as they are, that we may find the whereabouts of not only the Lofoten cod, but perhaps of other species of fish, such as sea herring or capelin, which like the cod only approach the shore at certain times of the year. In all probability the full-grown cod remain here during the whole Summer and Autumn, and it is not until their reproductive organs are fully developed (which in my opinion is as early as the third year after hatching) that they gather in great schools and swim together towards the nearest land to start spawning».

The report Sars drew up for 1870 is one of his longest — 25 pages. But he has lost the scent. Despite all his efforts, he cannot weave the various stocks of cod into one common pattern. Neither the cod fry nor the grown cod behave in exactly the same way as in former years. Sars seeks the explanation for this in the fact that the prevailing winds and currents have been unusual and have carried the fry to areas outside his reach. He sees that the fairly large cod has been led astray by sand-eel

and herring. But there are two short parts of this report we must include here. In the one Sars the artist allows us to experience a natural phenomenon, in the other Sars the practical researchworker deplores the «over-crowding» of the Lofoten fishery.

Sars has had himself rowed to a reef that the sea breaks over. The oarsmen have surely warned him that they cannot row too near, although the sea is calm, the swell can be treacherous. For a long time there is nothing to indicate a reef, but suddenly the reef «breaks», and then a boat might soon be smashed to matchwood. We shall let Sars describe this phenomenon in his own words:

«If one remains at a safe distance, one can without appreciable danger witness a wonderful and interesting sight, when the reef at last «breaks», as the fishermen say, as a heavy sea crashes over it. However, one sometimes has to wait a long time in vain. Sometimes a slow and apparently innocent rise of the water can be seen above the reef, with no interruption of the calm which reigns. Suddenly, however, one sees that the broad pyramid of water has taken on unusual dimensions, that a fine smoke seems to be rising from its top, and that there is a quick pushing movement, as if some monster of the sea was thrusting his snout out of the water; this is followed immediately by a muffled roar as from a passing storm, and one sees before one's eyes the wave rise up to an enormous height, a broad rampart of shining green, topped with seething foam, that rushes out in a great curv below, whipping everything to white spray. While one still sits lost in admiration at this proud phenomenon, one feels the boat being thrown hgh into the air and then down again into the depths, and thinks oneself already lost in the whirlpool; but this fear, although strong enough the first time, soon passes; for shortly everything is as calm as if nothing had happened, and the great combers from the shoaling, the combers on which the boat had ridden, get farther and farther away, and soon one hears the far-off roar of their breaking against the shore, as the final conclusion of the drama. After such an explosion the sea over the reef often remains calm for a long period; it seems to have emptied itself of all its anger, and to need a long rest before it has gathered strength for a new explosion, which does indeed follow after a time.»

«It is not only for my own pleasure, or that of my readers, that I have dwelt so long on the description of this natural phenomenon,» says Sars, «but because, as the following will show, it is closely related to my fishery studies.» He then describes how the whirling masses of water carry with them minute crustaceans and other animal plankton, spreading these helpless creatures out before the hungry fish. It is for this reason that a reef or shoal is a good fishing place.

Sars thought that the Lofoten fishery was over-populated, and that there were many other places along the coast where fish were prevalent. Here the practical researcher comes to the fore.

«The Lofotens have acquired the reputation of being the only place where the fishing industry can be carried on with profit in the winter, and when the time approaches for the fish to draw near the shore, young and old from all directions fit themselves out for the long and arduous voyage to the Lofotens. Often they suffer the severest hardships only to return home with no profit, or even with a loss, and often there may have been an opportunity for them to fish well and profitably very near their homes, almost outside their own front doors. The prevailing tendency of the fishermen to congregate in great numbers at the Lofoten fishing stations makes a suitable control and regulation of the fishing industry here extremely difficult if not impossible, with the result that one constantly hears complaints of collisions between the fishermen, with resultant loss of fish and gear. Neither can the new Fisheries Act be said to have contributed to preventing these entanglements, which have year by year grown in dimension, to the extreme detriment of the fishing industry, especially where the main part of the fishery has fallen to a fairly restricted area, such as at the fishing stations of the East Lofotens. There would thus seem to be an even greater inducement to inquire most carefully into the question of whether other points along the coast might not also be suitable for the winter fishery, which would lead to a more even distribution of the fishermen. It would seem that this might best be left to the fishermen themselves; but old custom has grown so fast in most of them that we cannot expect anything will be done unless the road is first broken by measures taken by the authorities.»

For six years Sars had carried on his studies from a rowboat. His research was directed neither from a navigating bridge, nor from a desk. When Sars leaned over the gunnel his trained eye could see the cod eggs which on a calm day collected in orderly geometrical patterns right up at the surface, and with his water glass he could follow the path of the young fish over sandbanks and through the forests of seaweed.

But the cod had outgrown him. He was convinced that the older stages for which he was looking had sought deeper water out by the banks, and he needed a boat larger than a rowboat. In 1871 he got the money to hire a decked vessel, and made four trips out to sea. The weather was unfavourable, but on one of his trips he got as far as about thirty miles off Storegga (the «Big Edge», part of the submarine bank that ranges the coast). On another trip he sounded his way out to find suitable bottom for setting a short length of line. The current was so strong that the sloop in which he was sailing began to drift off, and the line had to be drawn after only half an hour. No-one expected any fish, but to the surprise of all the catch was good, 77 fish on one tub of line. But it was not the fish that was most important this time.

Sars had made a few dredging hauls, and had brought up both animals and samples of bottom material from the coastal bank, and this was enough to lead him to put forward a completely new theory concer-

ning the origin of the continental shelf. «I shall here only state that my studies of the composition and fauna of the coastal banks have led me to the astonishing conclusion that the major part, if not the whole, of the extensive area of the floor of the sea that extends between the coast and the so-called «Big Edge,» the slope at the edge of this area, has been raised above the surface of the ocean, and that the margin of the «Big Edge» itself has once been the shore-line, and has perhaps been the original coast of the country.»

Sars points out the practical importance of a better knowledge of the continental shelf. For such a study a sailing vessel is, however, unsuitable, as too much time is lost. A steam vessel would make it possible to do many times as much work in a comparatively short time.

In 1872 Sars went to Stavanger and boarded the S/S «*Hansteen*», which was engaged in sounding the coastal banks off Jæren. It was not exactly these coastal waters that interested Sars the most, but theMinistry of the Interior had instructed him to take a look at the Spring Herring districts. Axel Boeck was still in charge of the herring, but Sars loyally declared himself willing to carry out the intructions of the Ministry, and on his return to send any results he might have reached to Axel Boeck.

Onboard the «*Hansteen*» Sars was given his own cabin. He was there as a zoologist and scientist, and was supposed to be interested only in strange marine animals, but his real intention was clear. Sars wanted to know whether the coastal banks could form the basis for Norwegian fisheries.

The «*Hansteen*» sounded its way mile after mile out from the coast. For a long stretch the depth remained the same, 140 to 150 fathoms, and the bottom was «the same soft, viscous clay (ooze)». As the vessel approached the North Sea plateau the depth grew less, and the dredge hauls showed that bottom consisted of sand, gravel and pebbles. It was here the North Sea cod had its home. Sars caughed it, and found that it was in all essentials similar to the Lofoten cod.

As the «*Hansteen*» was to be present at the arrival of the Crown Prince for the unveiling of the statue of King Harald, Sars decided to put an end to his pleasant existence onboard and to go off on his own to do some research on the herring.

SARS AND THE HERRING

The herring had been the object of study for a number of years, both in Norway and in Sweden. The researchers of the day were in just as great disagreement as they are to-day, and on the same points. The situation was not improved when Sars joined their ranks, because he

had still different ideas. The questions under discussion were where the spring herring was when it was not near the coast; whether what is called summer herring, or fat herring, is a special stock; whether the herring fisheries in Bohuslän were based on a herring stock of their own, or if it was the spring herring that ran so far south. Then, as now, it was the fluctuations in the herring fisheries which were the great problem.

Axel Boeck had compiled a considerable body of historical material to throw light on former fluctuations in the herring fisheries. Sars recognised that these would be of great value in future herring research, but he did not feel convinced that there was justification for speaking about herring periods.

In Bohuslän there had been a good and reliable herring fishery from 1747 until 1808, when the fishery abruptly ended. For many years it was hoped that the herring would return, but when it was realised that it had gone for good the Swedish government made a grant of 50.000 riksdaler for an experimental herring fishery in deep water. When this practical study led to no result, the zoologist S. Nilsson was entrusted with the task of investigating the question. His report met with severe criticism, and a committee was appointed to examine his assertions. All the opposition Professor Nilsson met with has brought us a great advantage, it has given us a great deal of information which would otherwise probably have been lost.

In 1864 a small steamer of 47 register tons, with a 20 horsepower engine and a crew of six or seven, entered the harbour of Vadsø. Its skipper was Svend Foyn — Norway's Henry Ford — practical, untiring, strong in his confidence in himself. His voyage to Finnmark was by nature of an experiment, he wanted to look into the possibilities for whaling. In the first year the catch was very poor, but each year saw constant improvements in his equipment. His first success came in 1868, when he caught 30 whales. Although he used two vessels in 1869 he caught only 17, but in the following year the catch rose to 36. Svend Foyn built an oil refinery and a guano factory at Vadsø. He began earning money, and this was just as well, for his five years of experiment had cost about 360.000 Norwegian kroner, no small sum a hundred years ago.

Now the whaling industry really got wind in its sails. The one whaling station after the other was built up on the coast of Finnmark, the new companies having to pay Svend Foyn for the right to use the new equipment.

In 1874 the Ministry of the Interior asked Sars to make a study of Svend Foyn's whaling activities, and the injurious effects they were claimed to have on the fisheries. The fishermen along the coast of Finmark regarded with little favour that great concern which had taken possession

of their waters, and which was now wiping out the whales that had faithfully chased capelin and cod towards the coast.

Sars arrived in Vardø in July, 1874, and travelled on to Vadsø, where he spent every day for three weeks examining all the whales brought into the station there. It proved that the type of whale caught by Svend Foyn was the blue whale, which does not live on herring or cod, but on a small shrimp-like crustacean, «krill» that occurs in colossal quantities. Although there was plenty of herring in the Varanger Fjord, Sars found only krill in the stomachs of the blue whales. It was other species of whale that chased the capelin when it came towards the coast to spawn, and followed it so sea again after the spawning. These whales, however, were of little interest to Svend Foyn, as they were smaller and less rich in blubber than the blue whale, which came later in the year, after the capelin and cod had left the coast.

In his report to the Ministry Sars stated that the complaints were unfounded, as the blue whale and the capelin could have nothing whatsoever to do with each other. But the opposition to the blue whale fishery did not die down, and soon drastic measures were taken. In 1904 the fishing of whales off the coast of Finmark was prohibited for a period of 10 years. This forced the Norwegian whalers to look for other fishing grounds — grounds they found in Antarctic waters.

Let us return to Sars' report for 1874. The herring had revolted, had left their southern spawning grounds, and had gone north. In 1873 and 74 large herring were caught in great quantities in coastal waters from East Finnmark to Bodø. The fishermen claimed that this herring left the coast before spawning, but when herring was left trapped in a large shore seine in a bay at Landegode, outside Bodø, until well into January the water was «whitened» by the milt of the male fish — the herring had spawned. Then Sars admitted that he would have to revise many of his former opinions on the biology of the herring, not only those concerning its migrations, but also those concerning the connection between spring herring and large herring.

The herring rang the changes with such versatility that they also succeeded in softening up Sars' opinions as far as periods of occurrence were concerned. Sars did not even like to allow this expression to pass his lips, but as sober and critical researcher he relied only on factual information and observations. He could not base his opinions on uncertain legends and approximate dates. However, he understood that there must be one or more reason for the herring having approached the coast in North Norway instead of West Norway, and he pointed out the unusually favourable ice conditions in the most northern waters, and the unusual amounts of Siberian red pine that had come into Sørøy in West Finnmark

as driftwood. Sars thought that this might be an indication of altered currents, and that these might have some influence on the distribution of the herring in the sea.

We can to-day see that Sars followed the cod and the herring as far as it was possible for him with the means at his disposal. He was therefore not letting them down when he in the following years included other Norwegian fisheries in the programme he drew up for his «holidays».

After spending ten years studying the herring and the cod he continued with the mackerel, lobster and seine fisheries. It is an experienced research worker who speaks in his reports on these fisheries. He knows what to look for, and where to look for it. The youthful, rather sentimental Sars has now become brusque and concise, but he remains just as thorough, and just as critical of fanciful explanations of the conduct of fish.

THE THREE EXPEDITIONS TO NORTHERN WATERS

1876 was again a memorable year in Norwegian marine research — it saw the first Norwegian expedition sent out to the waters between Norway and the Færoes and Iceland. The zoological staff consisted, in addition to Professor Sars himself, of D. C. Danielssen, the Chief Physician of a hospital, and Herman Friele, a merchant. Both were from Bergen.

The great deeps of these waters, the Norwegian Sea, were sounded, trawled and dredged, and the expedition brought home quantities of new species. During the whole time Sars had the fisheries in his thoughts, and was always on the watch to discover where the herring and the cod had their whereabouts when they were absent from the coast of Norway. As far as the herring was concerned, he soon realised the role which animal plankton must play in the migrations of the herring. He realised that a quick-swimming pelagic fish such as this could lay behind it such distances that it had the whole of the Norwegian Sea as its playground.

The second Norwegian expedition left in 1877. More northern waters were now chosen, the expedition studying the area between North Norway and Jan Mayen, and bringing back a wealth of scientific material. Sars was still hunting the herring and the cod, and putting together all the small pieces he could find of his still incomplete picture of their migrations.

In 1878 an expedition visited the waters around Bjørnøya and Spitsbergen, reaching the Norwegian Islands off the north-western point of Spitsbergen, near the 80th degree of latitude. An incredibly rich cod fishery was being carried on here by Norwegian vessels. As an example

of how plentiful supplies of fish were, Sars tell us that one of the vessels, the «*Ishjørn*» sent out three boats at ten o'clock in the evening, each manned by two men. At half-past four in the morning the boats came back loaded to the gunnels with 1.153 large cod. After having gutted and split the fish and rested for a while, the six men went out again at eight o'clock, returning at half-past one with 1.100 cod. In the course of twelve hours fishing during a period of less than 24 hours they had caught 2.253 cod «which is about 375 fish per man, or more than 1 fish every other minute.»

Sars examined the Spitsbergen cod. He found no roe or milt in it, although it was very large. He found no small fish, and no cod fry along the shore. He posed the question: «Where does the Spitsbergen cod reproduce?», and writes: «Now that our last expedition has procured us a complete picture of the formation of the ocean bottom and the other physical and biological conditions in the waters in which we sailed, this question appears just as easy as it formerly seemed difficult. There can be no doubt but that the mature individuals go south and appear along our coast as the well-known Lofoten or winter cod.»

Sars then marked the paths of migration of the Lofoten cod and the Finnmark cod on his map. While he allows the Lofoten cod to make its spawning migration to the Norwegian coast, he holds the immature Finnmark cod back in the Barents Sea, not letting it join the schools of Lofoten cod until it is mature. It was as easy as that.

As a reward for his labours Sars received a gift from his cod.

Skipper Ingebrigtsen of the sloop «*Amalie*» of Tromsø caught a cod at Spitsbergen that had a fishhook in its jaw, with a little piece of the snell still attached. The hook was sent to Sars. The snell was of a quite different type from that used at Spitsbergen, but of the same type as fishermen used in Lofoten and Finnmark. The flesh of the fish had grown over the hook, which must have been there for a long time.

The cod had surrendered!

«YOU WILL NEVER BE BORED!»

In this survey of the early history of Norwegian fisheries research we have only been able to mention the most significant episodes, the most characteristic periods, and the most outstanding names.

The name and work of Georg Ossian Sars have been spoken of at some length, simply because he is the father of modern marine research. To researchers of the present day his fiskery studies and his reports on them seem to have dimensions of a life-work.

In reality these reports only tell the story of how Sars spent his

holidays, and perhaps a few extra weeks of leave of absence when the Ministry so requested. When these reports are placed on a book-shelf beside his other publications they are as an almanac to an encyclopedia in serveral volumes.

When Axel Boeck died, in 1873, G. O. Sars became the sole leader of practical scientific research on the Norwegian fisheries, but as early as 1870 he had been attached to the University of Christiania. In 1874 he became Professor of Zoology there, but continued to lead the fisheries research until 1893, when Johan Hjort took over this work.

To us ordinary mortals it appears incredible that a man could do as much in one life-time as Sars did. It is too easy just to say that he was a genius. He was hard-working, never wasted his time. He handed over his salary to his mother, later to his sister, and received a little back for pocket money. With his back straight as a ramrod he left the University on the minute — so punctually that one could set one's clock by time — but before crossing Karl Johan he went over to the University clock to check his watch by it.

A young student who had found a relict crustacean in Lake Hurdal took it to show to Sars — for it was a crustacean that had only lived in the sea. Noone said «come in» when he knocked on the door, but when he opened it a crack he saw Sars' grey head bent over the microscope. Sars did not look up until the student had reached his table, then his glance returned from the world he lived in. The student explained his mission. «That's quite right,» said Sars, «I have found it there myself. But sit down!» He questioned the young man with interest about his plans and aims. When his visitor was about to leave, Sars rose from the rocking chair he had been sitting in, and said: «You are at the beginning of your career, I am at the end of mine — but I can tell you one thing, you will never be bored.»

THE GOLDEN AGE OF NORWEGIAN FISHERIES RESERCH

It is impossible to describe the fifteen-year period which made our country one of the foremost in the field of fisheries research without describing the man responsible for it, Professor Johan Hjort (1869—1948).

Johan Hjort first studied medicine, and had taken the first part of his medical degree examination before deciding to take up zoology instead. He studied in Munich and Naples, taking his doctor's degree in Munich in 1892. In 1893 he was appointed to a curatorship at the University of Christiania, at the same time becoming G. O. Sars' successor in the work of leading practical fishery research.

In 1897 he became the Director of the biological station at Drøbak, and he now began to organise the type of research which we to-day call marine research. From German, Danish and Swedish researchers, who represented various fields within the study of the sea and its life, Hjort received impulses which enabled him to develop the great idea which inspired him, that of establishing a free institution which would have at its disposal experts in as many as possible of the fields which concerned the fisheries.

One must be permitted to say that he started with almost empty hands, but a practical experiment carried out by him gave such results and such prospects for the future that he received support for his plans.

Hjort had quite simply used a fine-meshed trawl in deep water in the Oslo Fjord, and had there found large quantities of deep-water shrimps. This experiment marked the beginning of a new and profitable fishery, which has in the course of the years developed into one of the larger and most reliable of our fisheries.

Hjort then bent his foresight, his enormous energy, and his iron will to the task of carrying out a wellplanned study of fjords, skerries and fishing banks, a study that was to do the spade-work for future research. So, in the years 1897 to 1899, modern Norwegian fishery research began to take form. It was no longer a question of only cod or herring, it was a question of the sea itself and all the life it held. In 1899 Hjort asked for money for a good-sized marine research vessel of special construction. It was a fairly large amount that he required, by the standards of the day. Hjort was advised against asking for funds for such a large vessel, but he answered that if he asked for a small sum for a small boat, he risked getting nothing at all. The amount would have to be so big that Parliament really understood that the question was important. And important it was! The launching of S/S «*Michael Sars*» in 1900 marked the beginning of the golden age of Norwegian fisheries research.

Hjort had chosen a vessel of trawler type, simply and practically fitted out, seaworthy and easy to manoeuver. From each of the voyages the «*Michael Sars*» made in the following years a stream of new information flowed in about the sea and its fisheries.

Hjort also took an active part in many other activities. In 1900 he had become a member of the newly-formed Norwegian Fishery Authority, which had its seat in Bergen. He was among those who founded the International Council for the Exploration of the Sea, with its seat in Copenhagen. He initiated the pioneer courses in marine research at the Bergen Museum, courses attended by many foreign researchers. In the middle of all this he completed the one major publication after the other.

To-day these works are memorials to the short-lived hegemony of Norwegian marine research.

When we read the article written for this book by Brock and Koefoed on the men of the old guard, we see what type of colleague Hjort was able to attach to his institution- and what conditions they worked under! Like a blustering captain Hjort went from the one the other to discuss their research tasks, to advise and criticise.

In 1906 Hjort became sole Director of the Fishery Authority, which was re-organised in the same year.

In 1901 Hjort met the great English oceanographer Sir John Murray at a meeting of the International Council for the Exploration of the Sea in Copenhagen. The Englishman thought that a study of the Atlantic might provide an explanation for some of the problems of northern waters, and after the meeting Sir John wrote to Hjort and declared himself willing to cover all the expenses of an Atlantic expedition, if the Norwegian Government would make the «*Michael Sars*» and a group of scientists available for a period of four months. The Norwegian Government arranged the matter very quickly, and in the summer of 1910 Sir John Murray and Johan Hjort, accompanied by a staff of young and interested research workers sailed in the «*Michael Sars*» on the expedition which was to become so famous. The report in which the two leaders and the younger researchers Appelløf., Gran, and Helland-Hansen give an account of the results achieved, was not long in appearing. It was published in 1912, as a book: «The Depths of the Ocean», a work which became, and still remains, a bible of marine research.

In the following years it was the fluctuations in fisheries which became the central problem. A longforgotten discovery, that the scales of tha carp bore annual rings, was rediscovered and utilised by German researchers. Did this also apply to our own salt-water fish? Herring scales proved to have annual rings! And so did those of cod, saithe and haddock!

In 1904 a gigantic year-class of herring was born, and since scale samples were now taken each year and the age of the herring determined, it was possible to prove that in 1909 the herring schools consisted mainly of five-year herring, in 1910 mainly of six-year herring, and in 1911 mainly of seven-year herring.

The question of whether this would lead to the deduction that the great variations in the herring stock were due to there being good years and bad years at sea as on land will not be discussed here, because the question which immediately follows, the question of *why* an abundant

year-class should occur, proved an overwhelming challenge from nature to Dr. Hjort and his staff.

Because Hjort's investigations had been so comprehensively planned and carried out, information was now also available concerning the food of the newly-hatched fish. The minute organisms of the sea flourished most lavishly just at the time newly-born fish larvae are about to come to grips with life on their own. When their «feeding bags» have grown light they begin to take an interest in the glittering particles of life that float like golden and silver dust in the sea around them. Hjort thought that if the crop of these small organisms also varied from year to year, or if it did not appear on the table at the right time then this might be the reason why good herring or cod year-classes were born in some years, and poorer year-classes in others. In other words, the roots of the great problem of the Norwegian fisheries — their instability — might be found in the variations in the plankton production of the sea.

NORWEGIAN FISHERIES RESEARCH HAD A NEW CLUE TO FOLLOW

In 1914—15 on the request of the Canadian government Hjort organised fishery studies on the Atlantic coast of Canada, using Norwegian research workers. But now the first World War was in progress.

In the autumn of 1915, when a food shortage was threatening Germany, the Germans attempted to make large purchases of Norwegian fish. This did not suit Great Britain, «starving out» Germany was considered an effective weapon. It was planned to force Norway to prohibit export of fish and fish products, on the threat of stopping the supply of everything necessary for the Norwegian fisheries. Hjort saw clearly that either alternative would have disastrous consequences, and he went to London to save the Norwegian fisheries. His reputation and his good connections, but not least his dynamic personal qualities, enabled him to persuade the English to choose a third alternative — the British authorities decided to set aside ten million pounds for the purchase of Norwegian fishery products. The buying was conducted through cover men, a fact only few realised, and the result was that prices rose to giddy heights. The ten million pounds melted away in a very short time. Hjort was again sent to England, and the English authorities now made 14 million pounds available, but on the condition that wholesale buying be organised on a firmer basis. An agreement to this effect was concluded between England and Norway on the 5th of April, 1916. According to the provisions of this agreement there were to be maximum prices, with which all British wholesale buying would conform.

All this time HJORT had assumed that the agreement would be made public, but the Norwegian Government insisted that it should be kept secret. HJORT claimed that this would be impossible, refused to have any part in it, and asked to be relieved immediately of the Office of Director of Fisheries. The Government gave him an indefinite leave of absence, but HJORT went for good, and the great days of Norwegian fisheries research were at an end.

Many of the young scientists who had worked with HJORT also left the field of fisheries research and found other tasks, only a few remaining to carry further the traditions and experience of the past.

BETWEEN THE WARS

In 1914 the «*Michael Sars*» was requisitioned by the Navy for service in safeguarding Norwegian neutrality. This was no great loss, her usual place of work had become a battlefield where ships were being sunk, and their crew being drowned by the thousands.

After the Armistice of 1918 a war-torn world tried to rebuild — but in every field there were new problems. The Norwegian fishing industry had danced around the golden calf for four hectic years — now its problem was not to get fish, but to get rid of the fish it caught. Who wants marine research under such conditions?

The social difficulties were so overwhelming that the focus of interest of the fisheries administration was shifted to the economic sector. The Norwegian fishing industry was struggling with failing markets and a shortage of capital and in order to keep it going it was necessary to evolve subsidy schemes which kept the boats afloat and the gear in working order. In the shadow of these administrative assistance programs Norwegian fisheries research continued to live an active but modest life, its work receiving little attention.

There is every reason to inquire whether those who refuse to give up at a difficult time do not perform a feat just as great as that of those who sail in a favourable wind, and receive due praise for doing so. There are some names we should remember from this period, among others those of PAUL BJERKAN, THOR IVERSEN , EINAR KOEFOED, EINAR LEA, and OSCAR SUND. All of them had studied under HJORT. Overtime pay, holidays, and home life were either unknown, or were strictly subordinate considerations. To-day we must thank them for not letting go, for continuing in their separate ways Norway's honourable contribution to fisheries research by studies which have become fundamental. LEAS' mathematical analysis of the variations and mortality of herring stock,

Oscar Sund's masterly analysis and diagrams of the fluctuations in cod stock, the daring expeditions made by Thor Iversen and Einar Koefoed to far northern waters, and the faithful watch kept by Paul Bjerkan on the brisling, form a worthy sequel to the golden age of the post-war period.

The Navy would not let the «*Michael Sars*» go — it was so convenient as a fishery protection vessel in Finnmark. All efforts to have the ship returned to its original purpose were of no avail, and Norwegian oceanographers had to ask for a new vessel. Brainwashed to modesty by long years of tribulation, they dared not set their sights higher than a small cutter 70 to 80 feet long, but as a small tribute to the man responsible for the great days of the past, the cutter was named the «*Johan Hjort*». Chance once brought the two together, Hjort stood on the quay as the cutter came in to Ålesund. «She is not very big,» he said, and declined an invitation to go on board. This was perhaps a manifestation of his bitterness against those who had rejected his ability and his will to work for the Norwegian fishing industry. The Norwegian Government later tried to repair the damage by appointing Dr. Hjort, in 1921, to the chair of marine biology.

Marine research continued in straitened circumstances until the second World War. With a ship so small as the «*Johan Hjort*» it was impossible to go out to sea, so the field of work was confined to near coastal waters. It was therefore the most important seasonal fisheries which were followed from year to year — the Lofoten cod fishery, the Finmark cod fishery, the herring fishery of West Norway, and the brisling fishery in the West Norwegian fjords. Thor Iversen and Einar Koefoed hired fishing vessels and went to the banks around Bjørnøya, near Spitsbergen, and along the eastern and western coasts of Greenland in order to find new grounds for the Norwegian fishing fleet.

The great problem in these years was that of obtaining funds for the operation of research vessels. The worst time came in the middle 'thirties, when even the operating expenses of the little «*Johan Hjort*» were struck off the budget. Fortunately, however, the new Fishing Industry Research Fund[1]) came to the rescue and the threat of a gaping hole in the long series of observations was averted.

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[1]) The Fishing Industry Research Fund was established by Resolution of Parliament on July 7th, 1927, as a Fund for the «promotion of the salt-water fisheries» with a capital of three million Norwegian kroner, this amount being part of the surplus of the Ministry of Supply. On the 1st of July 1939 the Fund was enlarged by about 1 million kroner from the so-called «Fund for the Promotion of the Fishery Industry», which had been founded on the 6th of July, 1927, by means of an allocation from State Lottery surplus.

On ordinary budgets there is seldom room for grants for new ideas, new proposals. These do not always require large sums, but are no less necessary for that. From the time the Fishing Industry Research Fund was founded in 1927 until it was withdrawn in 1960 it supported Norwegian fishery research with contributions of varying size. A glance at the use which has been made of these contributions shows us that it is this Fund that has created the Norwegian fishery research of the present day. Every single one of the investigations now on the program of the Institute of Marine Research has had its beginnings in modest contributions from the Fishing Industry Research Fund. This Fund gave faithful help as long as the «teething troubles» lasted. Once the doubtful period had passed, and those responsible felt firm ground under their feet, and knew that they were on the right track, it was easier to ask for investigations to be included in the ordinary budget.

It must be said to the credit of those who had this Fund created that it has played a most important part in establishing Norwegian fisheries research in the prominent position it now holds.

Prospects grew fairer towards the end of the 'thirties. In 1938 optimism reached such heights that rough designs were drawn for a larger research vessel — but the plan received no support. One of the arguments against it was that a research vessel would be of little use if there was no money to run it.

During the occupation of Norway it was of course impossible to carry out the usual cruises along the coast and the coastal banks, activities were restricted to occasional visits to certain areas. However, it was possible to keep in contact with the herring and the cod, so even from these difficult years we have age estimates giving us an unbroken series of observations on the age composition of herring and cod from the beginning of this century up to the present day. Those research workers who were able to continue during these years had an opportunity to examine more closely the material formerly collected.

When the war ended in 1945, and the important role applied research and highly developed technology had played in the conduct of the war became known, the belief began to gain ground that research for peaceful purposes might give just as sensational results for the benefit of mankind. A great wave of interest in research swept from country to country. Again it had wind in its sails, after having lain becalmed for many a long year.

Fisheries research received its share of the funds given for research purposes. In 1950 the Institute of Marine Research in Bergen was able to take into use the «*G. O. Sars*». The hull, which had originally been intended for a whaler was transferred to the Ministry of Fisheries. Its

size, 170 feet, was suitable for a sea-going research vessel. In the plans drawn up for the rebuilding of the vessel provision was made for the use of ordinary large fishing gear, trawls, purse seines, and drift nets, for a suitable laboratory and last but not least for accommodation which would make the vessel a pleasant place of work for those onboard.

It soon became apparent that the «*G. O. Sars*» was worthy not only of her name, but of the four million Norwegian kroner that were spent on rebuilding her.

After a few years came a demand from the fishermen for another research vessel, so that more fisheries could be covered. The little old «*Johan Hjort*» tried as long as she could to pull in the traces with her larger sister, but at last she had to give up. No impressive speeches were made when the little black boat that had served so long and so well retired to enjoy her old age as a ferry, but a few words ought to have been said to thank her for stretching far longer than her 79 feet.

In 1958 the new «*Johan Hjort*» was launched. She was a little bigger than the «*G. O. Sars*», broader, and with a greater tonnage. Eight years had been spent planning her, and just as many drafts were made before building was started. Her layout was, in broad outline, similar to that of the «*G. O. Sars*», which had proved eminently suitable for the varied purposes for which she was used. Several of the latest fishery research vessels built in other countries have been of the «*G. O. Sars*» type.

THE RESEARCH OF TO-DAY

Since the time Johan Hjort was the Director of Fisheries Norwegian fishery research had existed under conditions that were far from satisfactory as far as offices and laboratories were concerned. The various departments of the Directorate of Fisheries had to adapt their activities to accommodation in ordinary apartments, and scattered premises of various sorts. For many years the Institute of Marine Research worked in four different houses, in which the bathrooms, kitchens and pantries served as laboratories.

Plans for a separate building to house the whole of the Directorate of Fisheries were well advanced when Johan Hjort tendered his resignation. At that time Nordnes Park in Bergen was in the hands of the State, and the intention was to place the new building there. An architectural competition was held in 1917 and 1 million kroner was voted to cover construction costs. However, the project was repeatedly postponed, for varying reasons. The question of moving the Directorate of Fisheries to Oslo was raised, and contributed largely to delaying the commencement

of operations. The years passed, nothing was done, and in 1929 the vote of money was withdrawn. However, when the State offered Nordnes Park to the municipality of Bergen in 1928, the offer was made conditional on the State being allowed to repurchase up to two and a half acres if it should later be decided to erect a building to house the various departments of the Directorate of Fisheries. The Town Council accepted the agreement in 1938, and the municipality took over Nordnes Park on the 10th of February, 1940.

When peace came in 1945, and it was again possible to make plans for the future, it was bitter to turn the faded pages of the twenty-five year old blueprints, and wonder how long it would take to get so far. First the homes and industry of a war-torn country had to be rebuilt. But Nordnes Park was still there, and in the depths of the fjord outside the clearest sea-water one might wish.

Before the war the municipal authorities had lent the Institute of Marine Research a small site on the shore of Nordnes Point for the erection of a modest laboratory of marine biology. Both site and shoreline disappeared during the occupation, and the archeologists of the future will find them both buried under a more peaceful embankment on which citizens sit to enjoy the view. However, in 1945 the authorities were generous enough to lend a new site beside the old one, so all that was wanting was a building. And in 1946 a small provisional building really stood at Nordnes, a building where research workers could study live fish.

It was perfectly obvious that this little makeshift could not be used for long, and that the conditions under which the Directorate of Fisheries was working could not be allowed to continue. The problem of finding a suitable place in which the many and varied activities of the Directorate could be carried out grew more urgent. However, it was not until the tenacious question of moving the Directorate to Oslo was finally silenced that it was possible to make plans for a new building at Nordnes. It was only natural that the first problem to be tackled was that of providing the Institute of Marine Research with suitable offices and laboratories, as it was here that the shoe pinched worst.

The planning of an aquarium in Bergen was commenced concurrently with the plans for a new building to house the Institute of Marine Research. A special Aquarium Committee had been appointed in 1950 to promote this project, and a collection of private contributions had begun. From the very first, however, the Committee felt it to be of the greatest importance that the aquarium be built in conjunction with the Marine Research building. The Aquarium Committee wanted the projected aquarium to be not only for the general public, but also, to

as great a degree as possible, an institution that would serve science and the fisheries.

Negotiations between the Aquarium Committee and the Government led to the announcement of an architectural competition for one united project, to include buildings for both purposes.

In May 1960 the Institute of Marine Research moved into its tall new building in Nordnes Park. Between sixty and seventy persons who had hiherto only rarely seen each other, were now able to work under the same roof. In August of the same year the Aquarium opened its doors.

INTERNATIONAL COLLABORATION

All the North Sea countries have for many years had their research institutes for their fisheries. Some are large, some small, and they are working on problems which vary according to the fisheries and the fish which are most important to them. However, there are some species of fish, and some fishing areas, which are of interest to several nations. At the turn of the century the Scandinavian countries decided to co-operate in order to study the variations in the herring fisheries, and this gave the impetus to the foundation of the International Council for the Exploration of the Sea. The council has its permanent secretariat and seat in Copenhagen. The creation of this Council also created a means of contact between European fishery and marine research workers, and gave them an organ which could co-ordinate the work of the various countries.

At a meeting of the Council in 1902 Professor Hjort proposed the appointment of two committees, one to study the migrations of the herring and the cod, the other to investigate the question of whether the fish stocks of the North Sea were being overexploited.

This proposal brought into the light two of the main problems of the fishing industry. In the sixty years which have passed since then these two questions have been the focal points of practical fisheries research in all countries.

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